CLAIMS

1. A target system for determining alignment error in electronic substrates comprising:

a first contrasting set of elements forming a first grid pattern having a distance between elements; the first grid pattern having a plurality of grid segments in at least one of the x and y directions; and

at least one second contrasting set of elements forming a second grid pattern having a distance between elements, the second grid pattern having a plurality of grid segments in the x and y directions, the distance between the second set of elements being less than the distance between the first set of elements, the second grid pattern being disposed within one of the first grid pattern segments,

wherein alignment error may be determined by measuring distance between the first and second set of elements in the first and second grid patterns.

2. The target system of claim 1 wherein the first grid pattern has a plurality of grid segments in both the x and y directions.

3. The target system of claim 1 including a plurality of second grid patterns, each of the second grid patterns being disposed within different segments of the first grid pattern.

4. The target system of claim 1 including a plurality of second grid patterns disposed between different segments of the first grid pattern, and wherein each of the second grid patterns has a different distance between the second sets of elements therein.

5. The target system of claim 1 wherein the first and second sets of contrasting elements are etched in a layer on a lithographically produced substrate.

6. The target system of claim 1 wherein the second set of contrasting elements is formed in a resist layer on a lithographically produced substrate.

7. The target system of claim 1 wherein the grid segments formed by the first and second grid patterns comprise an array of rectilinear frames, each frame having x and y dimensions equal to the distance between elements in the first and second sets of elements.

8. The target system of claim 1 wherein the grid segments formed by the first and second grid patterns comprise an array of nominally square frames, each frame in the first set of having equal x and y dimensions corresponding to the distance between elements in the first set of elements and each frame in the second set of elements having equal x and y dimensions corresponding to the distance between elements in the second set of elements.

9. The target system of claim 1 wherein the grid segments formed by the first grid pattern comprises an array of rectilinear frames, and further including a pattern recognition feature associated with one of the frames.

10. The target system of claim 1 wherein the elements are selected from the group consisting of continuous lines, discontinuous lines, parallel lines, and aligned points.

11. The target system of claim 1 for use with an optical imaging system having a light source of wavelength λ, numerical aperture NA, and a partial coherence σ, and wherein the second set of elements in the second grid pattern has period p, corresponding to the distance between the second set of elements, defined by the expression:

$p \geq \lambda / (NA (1 + \sigma))$.

12. The target system of claim 1 for use with an optical imaging system having a light source of wavelength λ, numerical aperture NA, and a partial coherence σ, and wherein the second set of elements in the second grid pattern has period p, corresponding to the distance between the second set of elements, defined by the expression:

$p/2 < \lambda / (NA (1 + \sigma)) < p$.

13. The target system of claim 1 wherein the first and second grid patterns are formed on the same lithographic layer of an electronic substrate.

14. The target system of claim 1 wherein the first and second grid patterns are formed on different lithographic layers of an electronic substrate.

15. The target system of claim 1 including a plurality second grid patterns formed on different lithographic layers of an electronic substrate, each of the second grid patterns being disposed within different segments of the first grid pattern.

16. The target system of claim 1 including a plurality second grid patterns formed on different lithographic layers of an electronic substrate, each of the second grid patterns being disposed within different segments of the first grid pattern and having different distances between the second sets of elements therein.

17. A metrology tool system comprising a plurality of metrology tools, each metrology tool comprising a stage for securing a lithographically produced semiconductor substrate, an energy source, a lens for directing the energy source onto a surface of the substrate, a lens for capturing an image of a structure lithographically produced on the substrate, and an image processor for measuring distance between points on the image of the lithographically-produced structure on the substrate,

each metrology tool stage including an alignment target affixed thereto comprising a contrasting set of elements forming a grid pattern having a plurality of grid segments in the at least one of the x and y directions, each grid segment having a distance between elements equal to the same period, each metrology tool being adapted to be calibrated by measuring the period of the grid segments in the grid pattern on the alignment target associated affixed to the tool stage.

18. The metrology tool system of claim 17 wherein the grid pattern has a plurality of g rid segments in both the x and y directions.

19. The metrology tool system of claim 17 wherein the grid segments formed by the grid pattern comprise an array of rectilinear frames, each frame having x and y dimensions equal to the distance between elements in the set of elements.

20. The metrology tool system of claim 17 wherein the grid segments formed by the grid pattern comprise an array of nominally square frames, each frame having equal x and y dimensions corresponding to the distance between the elements in set of elements.

21. The metrology tool system of claim 17 wherein the grid segments formed by the grid pattern comprises an array of rectilinear frames, and further including a pattern recognition feature associated with one of the frames.

22. The metrology tool system of claim 17 wherein the elements are selected from the group consisting of continuous lines, discontinuous lines, parallel lines, and aligned points.

23. A method for determining alignment error in electronic substrates comprising:

providing on a layer of a substrate a first contrasting set of elements forming a first grid pattern having a distance between elements; the first grid pattern having a plurality of grid segments in at least one of the x and y directions;

providing nested within at least one of the first grid pattern segments, on the same or different layer of a substrate, a second contrasting set of elements forming a second grid pattern having a distance between elements, the second grid pattern having a plurality of grid segments in the x and y directions, the distance between the second set of elements being less than the distance between the first set of elements;

measuring location of the first set of elements in the first grid pattern;

determining the center of the first set of elements in the first grid pattern;

measuring location of the second set of elements in the second grid pattern;

determining the center of the second set of elements in the second grid pattern;

comparing the center of the first set of elements and the center of the second set of elements and determining alignment error of the first and second grid patterns.

24. The method of claim 23 wherein measurement of location of the first and second sets of elements in the first and second grid patterns is by scanning with an energy beam in a line across the first and second grid patterns and determining a reflection intensity pattern that signifies location of the first and second sets of elements in the first and second grid patterns.

25. The method of claim 24 wherein the determination of the centers of the first and second set of elements in the first and second grid patterns is by digitizing the location-signifying reflection intensity pattern with a predetermined pixel size, and wherein the comparison of the centers of the first and second sets of elements is calculated using pixel size of the centers of the of the first and second sets of elements.

26. The method of claim 23 wherein the first grid pattern has a plurality of grid segments in both the x and y directions and including a plurality of second grid patterns, each of the second grid patterns being disposed within different segments of the first grid pattern.

27. The method of claim 23 wherein each of the second grid patterns has a different distance between the second sets of elements therein.

28. The method of claim 23 wherein the first and second grid patterns are formed on the same lithographic layer of an electronic substrate.

29. The method of claim 23 including a plurality second grid patterns formed on different lithographic layers of an electronic substrate, each of the second grid patterns being disposed within different segments of the first grid pattern.

30. The method of claim 24 wherein the second contrasting set of elements forms a second grid pattern on the same, first substrate layer as the first grid pattern, and further including:

forming on a subsequent, second layer of the substrate another second grid pattern with second contrasting set of elements nested within a different first grid pattern segment, the first and second grids pattern on the first substrate layer being visible through the second substrate layer;

scanning with an energy beam in a line across the first and second grid patterns created on the first substrate layer and determining a reflection intensity pattern that signifies location of the first and second sets of elements therein;

scanning with an energy beam in a line across the first grid patterns on the first substrate layer and the second grid pattern created on the second substrate layer and determining a reflection intensity pattern that signifies location of the sets of elements therein;

aligning the reflected intensity pattern of the second sets of elements in the second grid pattern created on the first substrate layer and in the second grid pattern created on the second substrate layer;

using the reflected intensity patterns, determining the centers of the first and second sets of elements in the first and second grid patterns on the first and second substrate layers; and

comparing the centers of each of the second set of elements in the second grid patterns on the first and second substrate layers with the centers of the first set of elements of the first grid pattern segment in which it is nested and determining alignment error.

31. The method of claim 30 wherein the reflected intensity pattern of the second set of elements in the second grid pattern created on the first substrate layer is aligned with the reflected intensity pattern of the second set of elements in the second grid pattern created on the second substrate layer by using the reflection intensity pattern of the first set of elements in the first grid pattern.

32. The method of claim 23 wherein the grid segments formed by the first and second grid patterns comprise an array of rectilinear frames, each frame having x and y dimensions equal to the distance between elements in the first and second sets of elements.

33. The method of claim 23 wherein the grid segments formed by the first and second grid patterns comprise an array of nominally square frames, each frame in the first set of having equal x and y dimensions corresponding to the distance between elements in the first set of elements and each frame in the second set of elements having equal x and y dimensions corresponding to the distance between elements in the second set of elements.

34. The method of claim 23 wherein the elements are selected from the group consisting of continuous lines, discontinuous lines, parallel lines, and aligned points.

35. The method of claim 1 wherein the steps of measuring location of the set of elements use an optical imaging system having a light source of wavelength λ, numerical aperture NA, and a partial coherence σ, and wherein the second set of elements in the second grid pattern has period p, corresponding to the distance between the second set of elements, defined by the expression: $p \geq \lambda / (NA\ (1 + \sigma))$.

36. The method of claim 23 wherein the steps of measuring location of the set of elements use an optical imaging system having a light source of wavelength λ, numerical aperture NA, and a partial coherence σ, and wherein the second set of elements in the second grid pattern has period p, corresponding to the distance between the second set of elements, defined by the expression: $p/2 < \lambda / (NA\ (1 + \sigma)) < p$.